

Industrial Workers' Health and Environmental Pollution under the New International Division of Labor: The Taiwan Experience

ABSTRACT

Using Taiwan as an example, this paper conducts a historical analysis of the relationship between economic development in the new international division of labor and environmental pollution and industrial workers' health. Three industries—*asbestos, plastic, and dye*—were chosen for case studies. We trace the emergence of each industry in Taiwan and study each industry's protection of workers' health and environmental quality. Under the new international division of labor, the state's prioritization of economic development leads to lenient regulation. Under such state policies, employers have few incentives to invest in the protection of their workers' health and in the control of environmental pollution. Workers and the public are constrained in their efforts to protect their own health and prevent environmental pollution. This situation is exemplified by the deplorable working conditions and inadequate environmental pollution controls in the *asbestos, plastic, and dye* industries. Workers' health and the public's health are greatly compromised by economic development in the new international division of labor. (*Am J Public Health*. 1997;87:1223–1231)

Meei-shia Chen, PhD, MPH, and Chang-Ling Huang, MA

The global economy has undergone dramatic restructuring over the last 4 decades. Prior to World War II, the United States and the advanced industrialized countries of Western Europe dominated the world economy and controlled the manufacturing of industrial products, while the less industrialized countries served primarily as producers and exporters of raw materials. However, since the late 1950s, this classic international division of labor has been replaced by a new international division of labor (NIDL).¹ The steady rise of the NIDL has shifted the manufacturing of many industrial products from the advanced countries to less industrialized countries around the world.^{2–6}

As a result of this new division of labor, several less industrialized countries have experienced significant economic growth. The most prominent examples are Hong Kong, South Korea, Singapore, and Taiwan, commonly known as Asia's "four little tigers."^{7–9} By specializing in the production and export of light consumer goods, these countries have achieved high annual gross national product (GNP) growth rates.¹⁰

Although the NIDL has stimulated growth in some countries, this restructuring of the global economy is not without problems.^{5,11,12} Less industrialized countries, such as Taiwan, often overlook the complex social costs of the NIDL. The effects of the NIDL on the political, social, economic, and cultural aspects of participating countries have stimulated a great deal of research. Social scientists have studied the impact of the NIDL on development, labor, women, inequality, and social class in the less industrialized countries.^{5,11–17} However, little of this research has focused on the issues of health and the environment within these

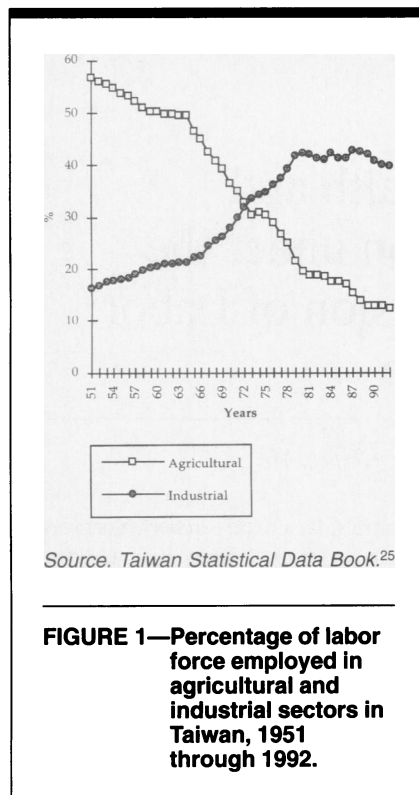
countries. Health researchers must seek to better understand what such large-scale social restructuring implies for the health of local populations. Using Taiwan as an example, this paper examines how the restructuring of the global economy relates to the problems of workers' health and environmental pollution in less industrialized countries.

We argue that when less industrialized countries participate in the NIDL, workers' health and environmental quality are greatly compromised. In the NIDL, less industrialized countries serve as the industrial product manufacturing sites for world markets. The majority of these products are exported to advanced countries.¹ In the less industrialized countries, maintaining the conditions necessary to stay competitive against other countries in the NIDL hinders the protection of workers' health and environmental quality. We can analyze this situation in terms of the roles of the three major players in economic development—the state, employers, and the general public (including workers). To achieve economic growth in the NIDL, the less industrialized state must promote conditions that will ensure a competitive investment environment, with lower production costs and higher profits. To foster these conditions, the state usually adopts a repressive labor strategy. Typically, the state suppresses trade union activities, adopts a low

Meei-shia Chen is with the Center for Health Administration Studies and the Graduate Program for Health Administration and Policy, University of Chicago, Chicago, Ill. Chang-Ling Huang is a PhD candidate in the Department of Political Science at the University of Chicago.

Requests for reprints should be sent to Meei-shia Chen, PhD, MPH, Center for Health Administration Studies, University of Chicago, 969 E 60th, Chicago, IL 60637.

This paper was accepted October 25, 1996.



minimum wage, underenforces the working wage policy, and increases the number of working days and working hours. Similarly, these countries commonly adopt lenient standards and loose enforcement policies regarding workers' health and safety and pollution control.^{3,6,9,18,19}

To stay competitive, employers in the manufacturing industries must keep their production costs as low as possible. One important approach employers use to reduce their overall production costs is to limit their investments in worker safety and pollution control. Workers in less industrialized countries are constrained in their efforts to protect their own health and safety. This is particularly true of the first generation of workers, who are generally drawn from the agricultural sector and who are largely ignorant of the impact of work hazards on their health.² Attempts by the workers to express their discontent are quickly suppressed by the state, and the pervasive ignorance of the environmental risks associated with production processes leaves the general public with little means to protect itself or the environment.

We used a case study approach to examine the development of three industries—*asbestos*, *petrochemicals*, and *dye*. We conducted a historical analysis of the interaction between the state, the employers, and the workers as it relates to the protection of workers' health and environ-

mental quality in these three industries. These industries were chosen because their emergence in Taiwan was a result of the NIDL. Information about the changes in workers' health status since the development of these industries would be beneficial to our study; however, no data on the health status of workers in these three industries are available. The job mobility of Taiwanese industrial workers is great, and most employers do not keep systematic records of their workers' health status; the few who have collected such information do not usually relinquish it for research purposes. Furthermore, some occupational diseases resulting from workers' exposure to the hazardous materials used in these industries may not have appeared yet, owing to their long latency. Therefore, we discuss the *potential risks* these industries pose to workers' health and to environmental quality by closely examining (1) the health-related conditions in which these industries developed and expanded in the context of the NIDL; (2) the state regulation of occupational health and safety and environmental pollution; (3) employers' efforts to maintain safe working conditions and environmental pollution control in these industries; and (4) the workers' role in protecting their own health and the public's role in preventing environmental pollution.

Since the literature and available secondary data provide little information about the workers' perspectives on the issues of occupational health and safety, we conducted ethnographic interviews with 13 union cadres from the plastic and petrochemical industries (which are larger than the *asbestos* and *dye* industries) in 1993. Most of the unions in Taiwan are under government control and do not necessarily represent workers' interests; therefore, we interviewed only cadres of the independent unions, who were elected by their workers.

Before we describe the case studies, we describe the historical process of Taiwan's participation in the NIDL and the role of the state, employers, and the public in the protection of workers' health and the prevention of environmental pollution in Taiwan. These two sections provide an important context for the understanding of our case studies.

Taiwan's Economic Growth in the New International Division of Labor

Taiwan's integration into the NIDL was the result of a political alliance

between the ruling Nationalist government and the United States. The Nationalist government moved to Taiwan in 1949, after its defeat by the Chinese Communist Party. Taiwan's security became a US concern when the Korean War broke out in 1950. Fearing that Communist China would advance into East Asia, the United States began to grant substantial military and economic aid to Taiwan to help stabilize the economy.²⁰ With this aid, the Taiwanese government adopted an import-substitution policy to protect the domestic market, to accumulate capital, to conserve funds, and to absorb labor. This policy lasted until the late 1950s, when the United States Agency for International Development (USAID) pressured the Taiwanese government to shift to an export-oriented economy.²¹

For the United States, Taiwan's integration into the world market served two purposes. Politically, Taiwan, along with other East Asian capitalist countries, formed an economic blockade against Communist China.²² Furthermore, bringing Taiwan into the world market created a large, low-cost overseas labor supply for some US industries. Between 1956 and 1961, the Taiwanese government relinquished its control over markets and exchange, stimulated private and foreign investment, and liberated export trade.²⁰ At the same time, USAID worked to publicize Taiwan as an investment site, and the US government facilitated and protected the flow of private capital into Taiwan.²³ Large Japanese corporations that manufactured electronic products, plastics, and textiles also began to invest in Taiwan. In 1965, the Taiwanese government established the Export Processing Zone, where domestic and overseas industries could manufacture products for export with government subsidies and reduced taxes. Overseas investment flooded into Taiwan to capture the cheap, abundant labor force and lucrative investment opportunities. Taiwan gradually became a vital element of the global production process.²⁴

Once integrated into the world market, Taiwan developed one of the fastest growing economies in the world, with an average GNP growth rate of 8.8% between 1951 and 1992. Taiwan's rapid industrialization during this period is demonstrated by the increased percentage of the labor force employed in the industrial sector and the decreased percentage employed in the agricultural sector over the last 4 decades (Figure 1).²⁵ Between 1952 and 1992, the percentage

of export in Taiwan's GNP has increased fivefold, and this illustrates how successfully Taiwan has integrated its economy into the NIDL (Table 1).²⁵ Major export items have also shifted from agricultural products to industrial and manufactured products (Table 2).²⁵ By 1983, Taiwan had become the largest exporter of non-oil manufactured products among developing countries.²⁶

The State, Employers, Workers, and the Public in the Protection of Workers' Health and the Prevention of Environmental Pollution

The three major players in the development of Taiwan's economy—the state, the employers, and the public (including workers)—have been slow to control the hazardous results of their participation in the NIDL. The state has treated economic growth as its highest priority, putting the protection of workers' health and environmental quality second. For years, responsibility for environmental protection rested on a subordinate unit of the Department of Public Health, which had limited resources.^{27,28} Prior to the establishment of the Taiwan Environmental Protection Agency in 1987, two ministers of economic affairs warned that Taiwan could not afford to be "overly environmentally concerned" (*United Daily*, October 8, 1983, and September 8, 1986). Even after its establishment, the new Taiwan Environmental Protection Agency had to acquire approval from the Bureau of Industry before sending any major environmental protection act to the legislature.²⁹ Not surprisingly, the Bureau of Industry has been one of the leading voices of opposition to stricter environmental laws and enforcement.

The state's lack of commitment to the protection of workers' health is reflected by the inadequacy of its laws and regulations. Occupational health and safety remained unregulated until the 1970s, when Taiwan already had a reputation for producing numerous labor-intensive cheap consumer goods. The essential laws and regulations such as the Labor Safety and Health Law, Standards for the Prevention of Hazardous Effects from Specific Chemicals, Allowed Concentration for Hazardous Chemicals in the Workplace, and Rules on the Prevention of Poisoning from Organic Solvents were not promulgated until the 1970s or the 1980s.³⁰

Even after the laws and regulations were established, enforcement remained insufficient. There have not been enough occupational medicine professionals to supervise work sites and enforce laws, and these professionals are overworked and underpaid.³¹ Furthermore, many health specialists believe that the system of licensing these professionals has failed to stipulate sufficient training requirements.³² Factories are required by law to employ occupational hygienists, but a 1990 survey of 105 factories in central Taiwan found that 56.7% were not complying with the law.³³ In fact, our interviews revealed that many factories rent licenses from industrial hygiene and safety examiners rather than actually hiring licensed professionals, thus saving personnel costs.

Given the state's encouragement of greater exports and its lenient laws and regulations, Taiwanese employers have few incentives to be concerned with the health and environmental effects of manufacturing. The production processes used to manufacture the millions of consumer goods produced by Taiwanese industries expose local populations to high levels of workplace hazards and environmental pollution. Most employers either have no knowledge of workplace hazards or are aware of the hazards but fail to inform their workers.³⁴ A report on the results of a nationwide government inspection of factories in 1970 found that only 20 of 2775 plants visited had met the government safety and health standards.³⁵ A 1974 inspection of factories producing nonmetallic mineral products such as bricks and ceramics found that of 370 plants inspected, 279 had fallen below the minimum health and safety standards.³⁵ In 1985, one sixth of Taiwan's export goods were produced in 15 industries categorized by the Taiwan Environmental Protection Agency as the "most serious pollution-producing industries."²⁹ Many of these manufacturers do not have the appropriate facilities to control environmental contaminants. According to data released by the bureaus of environmental protection in Taiwan Province, Taipei City, and Kaohsiung City, among 5000 factories categorized as possible polluters in Taiwan in the mid-1980s, 4037 did not meet the environmental protection standards.²⁹

State policy constrains the ability of workers and the general public to protect the environment and their health. The state's NIDL-oriented economic policy has limited Taiwan's autonomy in deciding what or how much to produce, since production decisions have been largely

TABLE 1—Percentage of Export in Taiwan's Gross National Product, 1952 through 1992

Year	%
1952	8.0
1955	8.3
1960	11.5
1965	19.4
1970	30.4
1975	39.9
1980	52.6
1985	53.3
1990	46.5
1992	43.4

Source. Taiwan Statistical Data Book.²⁵

TABLE 2—Composition of Taiwan's Exports, 1952 through 1992

Year	Processed and Nonprocessed Agricultural Products, %	Industrial Products, %
1952	91.9	8.1
1955	89.6	10.4
1960	67.7	32.3
1970	21.4	78.6
1980	9.2	90.8
1990	4.5	95.5
1992	4.3	95.7

Source. Taiwan Statistical Data Book.²⁵

driven by the demands of foreign markets. Long-term authoritarian rule made collective action among workers and the general public virtually impossible. Prior to 1987, martial law prohibited strikes and social protests. Industrial workers and environmentally concerned citizens were discouraged from voicing their complaints through collective action.

Many workers remain ill-informed about and uninterested in occupational hazards.³¹ As in other newly industrializing countries, the first generation of Taiwanese industrial workers were drawn from the agriculture sector. These workers had no experience with industrial work and were ignorant about workplace hazards. Our interviews revealed that, even among the more independent unions, most union cadres were ignorant about occupational health and safety and environmental pollution. These union cadres told us that most workers were concerned

about wages and bonuses, rather than health issues. One told us that when he invited a medical professor to his plant to explain to the workers the meaning of their health examination reports, only 3 of the 200 workers in that plant showed up for the talk. The few cadres who were concerned about occupational health and safety and the quality of the environment usually found the situation difficult to change. These cadres complained about the opposition unions face in acquiring data from workers' physical examinations. Without these data, it is difficult for unions to give credibility to their complaints and to pressure either the state or employers to improve working conditions.

Public environmental consciousness did not develop until the 1980s, when rapid economic development and unregulated industrialization had already caused serious environmental pollution.³⁶ According to a comprehensive report on environmental pollution in Taiwan in the 1980s,^{9,37} the lower reaches of major rivers in Taiwan had been severely polluted and the air pollution in densely populated areas was already visibly higher than in previous years. The greatest problem, however, has been the widely accepted belief that environmental protection must be sacrificed to achieve economic development.^{38,39}

The Asbestos Industry

Asbestos has been widely used in industry over the past century. To date, more than 3000 products contain asbestos, including brake linings, hair dryers, insulation, textiles, cement, and pipes.⁴⁰

The inhalation of asbestos fibers is extremely hazardous.^{41,42} It causes asbestosis, a fatal disease characterized by the progressive scarring of lung tissue, resulting in shortness of breath.⁴²⁻⁴⁴ It also causes lung cancer^{45,46} and mesothelioma, a rare form of cancer in the pleural or peritoneal membrane.^{43,47} The estimated relative risk of mesothelioma among groups most exposed to asbestos is 500 times the risk of those not exposed.⁴⁸ The inhaled asbestos fibers can migrate throughout the body, and cancers of the gastrointestinal tract, larynx, and kidney have also been detected in asbestos workers, their family members, and residents living in the neighborhood of asbestos plants.⁴⁹ The latency period for asbestosis and cancer caused by asbestos exposure is very long, from 10 to 50 years.⁵⁰ Often, an individual is not aware

of the impact of exposure until 15 or more years later.

In the United States, it became clear by the mid-1960s that cancer rates among asbestos workers were extremely high.⁵¹ In 1976, the US Occupational Safety and Health Administration (OSHA) reduced the allowed asbestos concentration in the workplace from 5 to 2 fibers per cubic centimeter of air.⁵² In 1986, OSHA dropped the standard to 0.2 fibers per cubic centimeter.^{46,53} This standard was reduced to 0.1 fibers per cubic centimeter in 1994.⁵⁴

As the developed nations gradually recognized the dangers of exposing workers to asbestos, much of the manufacturing of asbestos products was shifted to countries with less restrictive occupational health standards.⁵¹ Employers in Taiwan, encouraged by the government's export-oriented economic policy, imported more raw asbestos materials, accelerated the manufacturing of asbestos products, and subsequently boosted their export of these products, primarily to the United States.

Manufacturing of Asbestos Products in Taiwan

Asbestos textiles were among the most important asbestos products. In 1970, Taiwan began the large-scale export of asbestos textile products to the United States,⁵⁵⁻⁵⁷ whose asbestos industry was facing increasing pressure to apply more costly workplace controls. In 1973, after OSHA announced a reduction of the workplace asbestos exposure limit, the amount of asbestos textiles exported to the United States from Taiwan increased threefold. Asbestos imports from Taiwan decreased slightly in 1974 and 1975, probably owing to the impact of an economic recession caused by the oil shock in the previous year. Nevertheless, Taiwan's exports continued to increase after that time, and they peaked at about 1.3 million pounds in 1978. Taiwan was the second largest source of asbestos textile imports to the United States among the countries without government regulations to protect asbestos workers or the general public from asbestos hazards.^{51,52}

By the early 1980s, an increasing number of asbestos products were found to be hazardous. US consumption of many asbestos products, including asbestos textiles, declined,⁴⁶ and US importation of asbestos textiles from Taiwan has decreased steadily since 1981 (Figure 2).^{56,57}

Asbestos Workers' Health and Environmental Quality

The Taiwanese government's regulation of and enforcement in the asbestos industry were extremely lenient. In the 1970s, while other countries developed special regulations governing the asbestos industry, Taiwan still treated the industry as one involving generic "dust" or "particulates," rather than extremely hazardous fibers.⁵⁸ Although the government classified asbestos as a special toxic hazard in 1989,⁵⁹ the workplace standard, 2 fibers per cubic centimeter of air, remained 10 times higher than the US 1986 standard.⁶⁰ Even this relaxed standard has not been enforced strictly; studies have shown that more than half of the asbestos factories exceeded this government limit.^{60,61}

Chang and colleagues' comprehensive study conducted in 1986 and 1987 uncovered deplorable working conditions in the asbestos factories in Taiwan.⁶¹ These particularly abject conditions created a threat that was unrecognized by many of the workers. None of the factories surveyed had ever measured the asbestos fiber concentration in the workplace, and only 21% of these factories measured the particulate concentration. Factories that produced brake linings, insulation, and textiles used a dry manufacturing process that generated flying fibers and dust. One third of these factories did not use exhaust ventilation to filter fibers out of the air. About 12% of the factories required workers to eat inside the manufacturing space, surrounded by asbestos fibers. About 61% of the factories provided their workers with masks that offered only limited protection from microscopic asbestos fibers. Most workers given masks failed to wear them, either because the workers were ignorant of the hazards of asbestos or because the masks were uncomfortable. None of the factories provided two lockers for each worker, so workers could store their street clothes and dusty work clothes separately, a practice that decreases the possibility of contaminating the worker's family. Only 12% of the factories provided educational materials about asbestos or hazard-relating training, and no factory had a full-time occupational hygienist. A 1989 study of a representative sample of asbestos factories in Taiwan⁶² confirmed these poor working conditions. This study also reported that workers were unaware of the extreme hazards of asbestos.

Taiwanese workers' job mobility and the long latency period for asbestos-related diseases make it impossible to assess the overall health impact of the development and expansion of the asbestos industry in Taiwan. However, a study of asbestos workers in Taiwan found a significant effect of asbestos exposure on the reduction of respiratory functions.⁶³

The factories that Chang et al. surveyed also failed to properly dispose of hazardous industrial waste. About 18% of the factories treated their production-related wastes as ordinary wastes, and 21% simply buried them. Many factories left waste in open areas on the streets or in yards to dry, exposing the community to pollution. Furthermore, 51% of the factories treated used bags of raw asbestos fibers as common garbage.⁶¹

The Petrochemical Industry

The development of the petrochemical industry made possible the wide use of plastic products in our daily lives.⁶⁴ However, by late 1972, the scientific community in Europe had confirmed that vinyl chloride, a major petrochemical used in the production of plastic materials, was a potent carcinogen. It causes a rare type of cancer, angiosarcoma of the liver, as well as more common liver cancers and cancers of the kidneys, brain, lungs, digestive organs, and respiratory system.⁶⁴⁻⁶⁶ Workers exposed to vinyl chloride are 500 times more likely to develop angiosarcoma of the liver than people who have not been exposed.⁴⁸ Vinyl chloride emitted into the environment from vinyl chloride or polyvinyl chloride plants also poses a threat to the health of nearby residents.^{64,67}

Manufacturing of Petrochemical Products in Taiwan

Taiwan's petrochemical industry emerged as a result of the NIDL. Few production facilities for downstream petrochemicals existed in less industrialized countries until the 1970s, when the profit rate of the petrochemical and plastic industries in developed countries began to level off. When developed countries established more stringent regulations on exposure limits and emission standards for vinyl chloride,³⁹ countries with adequate refining capacity found an opportunity to produce basic petrochemical materials and plastic products for the world market.⁶⁸ Taiwan's export of plastic products increased dramatically from 1961

through 1992.⁶⁹⁻⁷³ Taiwan's cheap labor and export-oriented development strategy, accompanied by the developed countries' demands for consumer goods, encouraged the Taiwanese government to further develop the petrochemical industry to stabilize the supply of raw and intermediate materials for the plastic industry.⁷⁴ This policy resulted in the rapid growth of vinyl chloride and polyvinyl chloride production since the early 1970s.⁶⁹⁻⁷³ By the mid-1980s, Taiwan had become one of the leading producers of petrochemical products in the world market.³⁹

Workers' Health and Environmental Pollution

In 1986, the petrochemical-related industry in Taiwan accounted for 22% of total production in the manufacturing sector.³⁹ The approximately 760 000 workers employed in the industry constituted 33% of the workers employed in Taiwan's manufacturing sector.³⁹ The health of these workers is hardly protected by the lenient workplace regulations the government has implemented.

In Taiwan, the exposure limit for vinyl chloride in the workplace has been 10 ppm since 1981.⁵⁸ Before 1981, exposure was not regulated. In contrast, the US standard has been 1 ppm since 1974.⁷⁵ Studies of Taiwanese vinyl chloride plant workers have already found evidence of liver damage.⁷⁶ Our interviews with union cadres in the petrochemical industry revealed that some workers are concerned about exposure to workplace hazards. One union cadre we interviewed said,

Since 3 years ago, each year there was a person who died of liver cancer. None of the three had a smoking or drinking habit, and all of them were between 35 and 40 years old. Everybody in the plant feels the shadow. The plant has been established for only 15 years, and there are already cases like these. Who knows how many more cases there will be in the future?

The petrochemical industry is one of the primary sources of Taiwan's environmental pollution.³⁵ The petrochemical industrial districts are notorious for their serious air pollution,^{77,78} which has had a negative health impact on nearby residential areas. A recent study of the health impact of petrochemical pollution in the southern part of Taiwan found that excess bone, brain, and bladder cancer deaths of children and adolescents were clustered in residential areas within 3 km of the petrochemical industrial complexes.⁷⁹

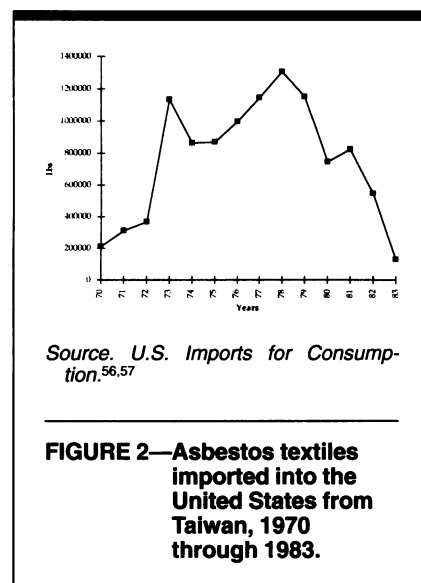


FIGURE 2—Asbestos textiles imported into the United States from Taiwan, 1970 through 1983.

In 1988, all 18 plants in the Lin Yuan Petrochemical Industrial District, the largest petrochemical district in Taiwan, were forced to stop operating for 3 days because of vehement protests by local residents who had been victims of the long-term severe air pollution. The protests ended only when the Minister of Economic Affairs went to the site and promised that employers would pay damage compensation of approximately US\$50 million to the local community.⁸⁰

The Dye Industry

The dye industry has experienced rapid growth in the world economy with the development of bright and inexpensive textile colors.⁸¹ However, since the early 20th century, researchers in the scientific community have confirmed that exposure to benzidine and beta-naphthylamine, two dye intermediates, leads to bladder cancer.⁸¹⁻⁸³ As with asbestos, the lag time between exposure and the appearance of symptoms varies considerably, with a mean of 20 years. Dye workers who were routinely exposed to benzidine have 14 times the probability of developing bladder cancer that unexposed workers have, and those exposed to beta-naphthylamine have 87 times the probability of developing bladder cancer.⁵⁰ This health threat led many developed countries to ban the production of these two chemicals.^{81,83} The dyeing industry also endangers the health of the general population through environmental pollution. Wastewater discharged by dyeing plants, if not properly treated, can contain large amounts of hazardous chemicals.



A peasant shows her crops, which have been damaged by acid rain. Photo courtesy of Chun-shen Chung of *Ren Jian* magazine, Taipei, Taiwan.



Crops are damaged by the air pollutants emitted from the China Petroleum Corporation, the state enterprise in Taiwan's petrochemical industry. Photo courtesy of Chun-shen Chung of *Ren Jian* magazine, Taipei, Taiwan.

Manufacturing of Dye Products in Taiwan

The development of Taiwan's dye and dyeing industry is a direct result of Taiwan's participation in the NIDL. With the rise of the NIDL, the world market for dyes and dyed products became accessible to developing countries. The Taiwanese government provided tax breaks to encourage the production of dye and the dyeing of consumer products for export to developed countries. As a result, Taiwan's dye production has been increasing sharply since the 1970s, with a marked production increase in 1985 as a result of the developed countries' introduction of more stringent regulation of their own dye industries.^{70-73,84}

The dye products that use benzidine and beta-naphthylamine as intermediates are still produced in Taiwan. In 1989, the Taiwan Institute of Economic Research reported that direct dyes accounted for

70% of all dyes produced in Taiwan, and that benzidine was still being used in producing some of these direct dyes.⁸⁴ The rate of direct dye export from Taiwan increased dramatically between 1976 and 1992.^{85,86}

Workers' Health and Environmental Quality

While other countries have banned the production and the use of benzidine and beta-naphthylamine, these chemicals are still used in Taiwan. This situation reflects the state's leniency in its regulations. Recent developments in the government's attitude toward the regulation of wastewater emission for the dyeing industry are also disturbing. The government is now planning to make the dye emission standard more lenient, claiming that any "environmental standard should weigh against the economic feasibility."⁸⁷

The US experience has demonstrated that without government intervention, most corporations will not protect their workers from known carcinogens in the workplace.⁸¹ Taiwan's problem is compounded by the difficulty of enforcing government regulations. It is estimated that there are approximately 600 dyeing plants in Taiwan, but 300 of them are not registered with the government and operate as underground factories. These underground dyeing plants are less likely than registered plants to have pollution control equipment, since they are not subject to government regulation.⁸⁷ In 1986, only 82 of the 300 registered plants had pollution control equipment.⁸⁸ According to a 1985 news report, in a survey of 25 plants with pollution control equipment, only 3 had equipment that met government requirements (*United Daily*, January 2, 1985). The Taiwan Institute of Economic Re-

search found that employers were reluctant to invest in wastewater treatment, and that those plants that already had wastewater treatment equipment did not operate it properly.⁸⁹ As a result, the dyeing industry's wastewater has been consistently listed by the Taiwan Environmental Protection Agency as one of Taiwan's most serious sources of pollution.⁹⁰ Because Taiwan's industrial sector is geographically intermixed with the agricultural sector, irrigation systems and drinking water are contaminated by wastewater from the dyeing plants.²⁸ Researchers in Taiwan have not conducted studies of the working conditions in dye and dyeing plants, reflecting a lack of concern about the health of the workers. However, the Taiwanese people are becoming increasingly concerned about environmental pollution caused by the emission of dye industrial waste.²⁸

Conclusions

Four decades of Taiwanese participation in the NIDL illustrate that the health of a society is shaped by economic and political forces. The state, employers, and other social groups have benefited greatly from the NIDL. Taiwan gained economic growth from its participation, but at the expense of public health and environmental protection. The industrial workers, the primary producers of Taiwan's new wealth, bore the heaviest burden, because they were directly exposed to the hazards of the manufacturing process. The residential areas surrounding the industrial plants were also exposed to environmental pollution, depriving the general public of the environmental quality they had enjoyed before Taiwan's industrialization.³⁷ The trade-off of workers' health and environmental quality for economic growth continued until the late 1980s, when the general public became more aware of the social price Taiwan had paid for its growth. Increased awareness of environmental quality and intensified pressure from anti-pollution protesters has prompted many legislative candidates to list environmental quality as one of their major concerns.⁹¹ Although less improvement has been made in workers' health and safety, officials of the Council on Labor Affairs informed us in a 1993 interview that more stringent standards for some hazardous chemicals and substances were being developed. This is probably a result of increased discontent among the working class.

Ironically, the increased pressure from environmental groups and workers' organizations in the last decade—although relatively weak compared with what other newly industrializing countries have experienced—and the rise in wages may have led to the movement of industrial manufacturing from Taiwan to China and Southeast Asia, where countries are eager to participate in the NIDL. This phenomenon replicates events in the early 1960s, when manufacturing moved from the developed countries to a less industrialized Taiwan.

In addition to the expansion and restructuring of the NIDL in Asia, more countries are expected to integrate into the global economy as the North American Free Trade Agreement and the unification of the European Community reduce barriers against the mobility of capital across national borders.⁹² Free trade agreements may enhance the ability of companies to relocate production to countries where government regulation of pollution and occupational health and safety is less stringent.⁹²

The Taiwanese experience suggests that the less industrialized countries are likely to sacrifice workers' health and environmental quality to achieve economic growth, unless there is enough pressure from the public and the working class to induce the state and employers to protect workers and the public. It is therefore imperative that health professionals in these countries educate workers and the public about occupational hazards and industrial pollution. These health professionals must support public demands that the state protect workers' safety and the quality of the environment. Furthermore, public health professionals should encourage international institutions such as the World Health Organization and the International Labor Organization to develop minimum international standards for the protection of the health of workers and the public, and encourage their governments to adopt these standards. Finally, there is a need for collaboration between public health professionals from countries involved in the NIDL to protect workers and the public. This international collaboration is also necessary for labor activists. The problems that Taiwanese health professionals and labor activists have faced as a result of the NIDL can serve as lessons for those countries joining the NIDL today. Health professionals and laborers in industrialized countries can also share their historical experiences in the protection of public health during the

industrialization process. In the United States, for example, the efforts of labor and public health professionals helped to establish the Occupational Safety and Health Administration and the Environmental Protection Agency. Such efforts should be modeled by laborers and public health professionals in those countries entering the NIDL to pressure their governments to develop similar regulating institutions. □

Acknowledgments

We would like to thank the union cadres in Taiwan whom we interviewed for their willingness to share their experiences and opinions; Chuck Levenstein at the University of Massachusetts at Lowell, William Parish at the University of Chicago, Howard Waitzkin at the University of California at Irvine, Robert Ginsburg at the Midwest Center for Labor Research, and Jack Lee in New York for their helpful comments and suggestions; Chun-shen Chung, of *Ren-Jian* magazine in Taiwan, for providing photographs illustrating the pollution of the petrochemical industry in Taiwan; Tracy Luks at the University of Chicago for her valuable assistance in editing; and Su-jen Quo at the Taiwan Yang Ming Medical University for her assistance in obtaining some relevant reports from Taiwan.

References

1. Frobel F, Heinrichs J, Kreye O. *The New International Division of Labour: Structural Unemployment in Industrialised Countries and Industrialisation in Developing Countries*. Cambridge, England: Cambridge University Press; 1980.
2. Bonacich E, Cheng L, Chinchilla N, Hamilton N, Ong P. The garment industry in the restructuring global economy. In: Bonacich E, Cheng L, Chinchilla N, Hamilton N, eds. *Global Production: The Apparel Industry in the Pacific Rim*. Philadelphia, Pa: Temple University Press; 1994.
3. Ross RJS, Trachte KC. *Global Capitalism: The New Leviathan*. Albany, NY: State University of New York Press; 1990.
4. Sanderson SE, ed. *The Americas in the New International Division of Labor*. New York, NY: Holmes & Meier; 1985.
5. Nash J, Fernandez-Kelly MP, eds. *Women, Men, and the International Division of Labor*. Albany, NY: State University of New York Press; 1983.
6. Marcussen HS. Changes in the international division of labour: theoretical implications. *Acta Sociol*. 1982;25:67-78.
7. Appelbaum, RP, Henderson J, eds. *States and Development in the Asian Pacific Rim*. Newbury Park, Calif: Sage Publications Inc; 1992.
8. Hamilton C. Capitalist industrialization in East Asia's four little tigers. *J Contemp Asia*. 1983;13:35-73.
9. Bello W, Rosenfeld S. *Dragons in Distress: Asia's Miracle Economies in Crisis*. San Francisco, Calif: Institute for Food and Development Policy; 1990.
10. *Domestic and Foreign Economic Statistic*

- Report. Taipei, Taiwan: Republic of China Ministry of Finance; 1994.
11. Gondolf EW, Marcus IM, Dougherty JP, eds. *The Global Economy: Divergent Perspectives on Economic Change*. Boulder, Colo: Westview Press; 1986.
 12. Ernst D, ed. *New International Division of Labor, Technology, and Under-Development: Consequences for the Third World*. New York, NY: Campus Verlag; 1980.
 13. Henderson J, Castells M, eds. *Global Restructuring and Territorial Development*. London, England: Sage; 1987.
 14. Sklair L. *Assembling for Development: The Maquila Industry in Mexico and the United States*. London, England: Unwin Hyman; 1989.
 15. Kamel R. *The Global Factory: Analysis and Action for a New Economic Era*. Philadelphia, Pa: American Friends Service Committee; 1990.
 16. Safa HI. Runaway shops and female employment: the search for cheap labor. *Signs*. 1981;7:418-433.
 17. Berberoglu B. *The Legacy of Empire: Economic Decline and Class Polarization in the United States*. New York, NY: Praeger; 1992.
 18. Hart-Landsberg M. *The Rush to Development: Economic Change and Political Struggle in South Korea*. New York, NY: Monthly Review Press; 1993.
 19. Castells M. Four Asian tigers with a dragon head: a comparative analysis of the state, economy, and society in the Asian Pacific Rim. In: Appelbaum RP, Henderson J, eds. *States and Development in the Asian Pacific Rim*. Newbury Park, Calif: Sage; 1992.
 20. Jacoby N. *U.S. Aid to Taiwan*. New York, NY: Praeger; 1967.
 21. Amsden A. The state and Taiwan's economic development. In: Evans PB, Rueschemeyer D, Skocpol T, eds. *Bringing the State Back*. Cambridge, England: Cambridge University Press; 1985.
 22. McKinley RD, Mughan A. *Aid and Arms to the Third World: An Analysis of the Distribution and Impact of U.S. Official Transfer*. London, England: Frances Printer; 1984.
 23. Schreiber J. *US Corporate Investment in Taiwan*. New York, NY: Cambridge University Press; 1970.
 24. Gold T. *State and Society in the Taiwan Miracle*. New York, NY: ME Sharpe; 1986.
 25. *Taiwan Statistical Data Book*. Taipei, Taiwan: Council for Economic Planning and Development, Republic of China; 1993.
 26. Gijsbert L. *Bridging the Gap: Four Newly Industrializing Countries and the Changing International Division of Labor*. Geneva, Switzerland: International Labor Office; 1988.
 27. *Republic of China Annual Report on Environmental Protection*. Taipei, Taiwan: Taiwan Environmental Protection Agency; 1982.
 28. *Republic of China Annual Report on Environmental Protection*. Taipei, Taiwan: Taiwan Environmental Protection Agency; 1990.
 29. Wu Y. The dirty spot on the beautiful gown: who should be responsible for industrial pollution? [in Chinese]. *Tien Shia Magazine*. October 1, 1986.
 30. *Laws and Regulations on Occupational Safety and Health*. Taipei, Taiwan: Association of Occupational Safety and Health of Republic of China; 1994.
 31. Stites R. Industrial work as an entrepreneurial strategy. *Modern China*. 1985;11(2): 227-246.
 32. Wang J. Facing the challenge of the problem of Taiwanese occupational disease [in Chinese]. *Health World*. 1992;81: 93-98.
 33. Chang P. The prospects and current situation of the prevention of occupational disease in our country [in Chinese]. *Ind Safety Health*. 1990;19:12-15.
 34. Wang J. Public health problems in the developing country: Taiwan as a case study [in Chinese]. *Chin Public Health J*. 1987;6: 1-15.
 35. Djang TK. *Industry and Labor in Taiwan*. Taipei, Taiwan: The Institute of Economics, Academia Sinica; 1977.
 36. Chen M. International trade and environmental protection [in Chinese]. *J Eng Environ*. 1990;12:49-54.
 37. The Steering Committee of Taiwan 2000. *Taiwan 2000: Balancing Economic Growth and Environmental Protection* [in Chinese]. Taipei, Taiwan: Institute of Ethnology, Academia Sinica; 1989.
 38. Lin J. The problem of environmental hazards in Taiwan [in Chinese]. In: Lin J, ed. *Reflections on Technology and Civilization*. Taipei, Taiwan: Pamier Bookstore; 1984.
 39. Shih S. On the future development of the petrochemical industry in Taiwan [in Chinese]. *J Eng Environ*. 1990;12:41-47.
 40. Berman D. Asbestos and health in the Third World: the case of Brazil. *Int J Health Serv*. 1986;16:253-263.
 41. Selikoff IJ. Cancer risks of asbestos exposure. In: Hiatt H, Watson J, Winsten J, eds. *Origins of Human Cancer*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory; 1977:1765-1784.
 42. Castleman B, Madan R, Mayes R. Industrial hazards exported to India. *Econ Polit Wkly*. 1981;16:1057-1058.
 43. Selikoff IJ, Churg J, Hammond EC. The occurrence of asbestosis among insulation workers in the United States. *Ann NY Acad Sci*. 1965;132:139-155.
 44. Council on Scientific Affairs. A physician's guide to asbestos-related disease. *JAMA*. 1984;250:2593-2597.
 45. Doll R. Mortality from lung cancer in asbestos workers, 1955. *Br J Ind Med*. 1993;50(6):485-490.
 46. Castleman B. *Asbestos: Medical and Legal Aspects*. 2nd ed. Clifton, NJ: Law & Business Inc; 1986.
 47. Wagner JC, Sleggs C, Marchand P. Diffuse pleural mesothelioma and asbestos exposure in the north western Cape Province. *Br J Ind Med*. 1960;17:260-271.
 48. Nicholson W. Research issues in occupational and environmental cancer. *Arch Environ Health*. 1984;39:190-202.
 49. Nicholson WJ, Perkel G, Selikoff IJ. Occupational exposure to asbestos: populations at risk and projected mortality—1980-2030. *Am J Ind Med*. 1982;3:259-311.
 50. Levy B, Wegman D. *Occupational Health*. Boston, Mass: Little Brown & Co Inc; 1983.
 51. Elling R. Industrialization and occupational health in underdeveloped countries. In: Navarro V, ed. *Imperialism, Health, and Medicine*. New York, NY: Baywood; 1979.
 52. Castleman B. The export of hazardous factories to developing nations. *Int J Health Serv*. 1979;9:560-606.
 53. *NIOSH Pocket Guide to Chemical Hazards*. Washington, DC: National Institute of Occupational Safety and Health; 1990. DHHS publication NIOSH 78-210.
 54. 29 CFR chapter XVII (1910.1001).
 55. *U.S. Imports for Consumption*. Washington, DC: US Dept of Commerce; 1975.
 56. *U.S. Imports for Consumption*. Washington, DC: US Dept of Commerce; 1980.
 57. *U.S. Imports for Consumption*. Washington, DC: US Dept of Commerce; 1985.
 58. *Republic of China Exposure Limit of Hazardous Materials in the Air of Working Environment*. Vol 5. Taipei, Taiwan: Committees on the Compilation of Republic of China Current Laws and Regulations; 1981.
 59. *Republic of China Annual Report on Environmental Protection*. Taipei, Taiwan: Taiwan Environmental Protection Agency; 1988.
 60. Chang HY, Wang JD. *Discussions on the Evaluation Model for the Hazards of Toxicology: Using Asbestos as an Example* [in Chinese]. Taipei, Taiwan: Taiwan Environmental Protection Agency; 1991.
 61. Chang HY, Wang JD, Chang JH, Chen CJ, Suo J, Wu MJ. Industrial hygiene survey for asbestos-related factories in Taiwan [in Chinese]. *Chin Health J*. 1988;8:161-171.
 62. Fu Z. Survey on the current condition of the asbestos industry in Taiwan [in Chinese]. *Taiwan Environ Protection*. 1989;4: 27-34.
 63. Chen C-R, Chang H, Suo J, Wang J. Occupational exposure and respiratory morbidity among asbestos workers in Taiwan [in Chinese]. *J Formosan Med Assoc*. 1992;91:1138-1142.
 64. Epstein S. *The Politics of Cancer*. New York, NY: Anchor; 1970:102-117.
 65. Smulevich VB, Fedotova IV, Filatova VS. Increasing evidence of the rise of cancer in workers exposed to vinylchloride. *Br J Ind Med*. 1988;25(2):93-97.
 66. Jones RD, Smith DM, Thomas PG. A mortality study of vinyl chloride monomer workers employed in the United Kingdom in 1940-1974. *Scand J Work Environ Health*. 1988;14(3):153-160.
 67. Infante PF. Oncogenic and mutagenic risks in communities with PVC production. In: Saffiotti, Wagoner, eds. *Occupational Carcinogenesis*. 1970.
 68. Fayad M, Motamen H. *The Economics of the Petrochemical Industry*. New York, NY: St. Martin's Press; 1986.
 69. *Yearbook of Taiwan Chemical Industry*. Taipei, Taiwan: Institute of Economic Research; 1993.
 70. *Industry of Free China*. Taipei, Taiwan: Council for Economic Planning and Development, Executive Yuan, Republic of China; 1973.
 71. *Industry of Free China*. Taipei, Taiwan:

- Council for Economic Planning and Development, Executive Yuan, Republic of China; 1983.
72. *Industry of Free China*. Taipei, Taiwan: Council for Economic Planning and Development, Executive Yuan, Republic of China; 1988.
 73. *Industry of Free China*. Taipei, Taiwan: Council for Economic Planning and Development, Executive Yuan, Republic of China; 1993.
 74. *Petrochemical Industry*. Taipei, Taiwan: Chinese Information Service; 1985.
 75. *NIOSH Pocket Guide to Chemical Hazards*. Washington, DC: National Institute of Occupational Safety and Health; 1985. DHHS publication NIOSH 78-210.
 76. Wang FS, Wu YG, Shih DH. *Report on Liver Injury of VCM Plant Workers in Taiwan* [in Chinese]. Taipei, Taiwan: Council on Labor Affairs, 1991.
 77. *Republic of China Annual Report on Environmental Protection*. Taipei, Taiwan: Republic of China Environmental Protection Agency; 1986.
 78. *Republic of China Annual Report on Environmental Protection*. Taipei, Taiwan: Republic of China Environmental Protection Agency; 1987.
 79. Pan BJ, Hong YJ, Chang GC, Wang TM, Cinkotai FF, Ko YC. Excess cancer mortality among children and adolescents in residential districts polluted by petrochemical manufacturing plants in Taiwan. *J Toxicol Environ Health*. 1994;43:117-129.
 80. *Yearbook of Petrochemical Industry*. Taipei, Taiwan: Chinese Information Service; 1993.
 81. Michaels D. Waiting for the body count: corporate decision making and bladder cancer in the US dye industry. *Med Anthropol Q*. 1988;2:215-232.
 82. Anthony HM, Thomas GM. Tumors of the urinary bladder: an analysis of the occupations of 1030 patients in Leeds, England. *J Natl Cancer Inst*. 1970;45:879-895.
 83. Tsuchiya K, Okubo T, Tshizu S. An epidemiological study of occupational bladder tumors in the dye industry of Japan. *Br J Ind Med*. 1975;32:203-209.
 84. *Yearbook of Chemical Industry*. Taipei, Taiwan: Taiwan Institute of Economic Research; 1989.
 85. *Import-Export Annual Statistics*. Taipei, Taiwan: Ministry of Economic Affairs, Republic of China; 1980.
 86. *Import-Export Annual Statistics*. Taipei, Taiwan: Ministry of Economic Affairs, Republic of China; 1993.
 87. *Republic of China Economic Yearbook*. Taipei, Taiwan: Economic Daily Publications; 1993.
 88. *Republic of China Economic Yearbook*. Taipei, Taiwan: Economic Daily Publications; 1987.
 89. Lin TY, Chen GS. An analysis of the prevention of dyeing industry's pollution [in Chinese]. *Taiwan Econ Res Monthly*. 1989;106-111.
 90. *Republic of China Annual Report on Environmental Protection*. Taipei, Taiwan: Republic of China Environmental Protection Agency; 1991.
 91. Hsiao HH. The rise of environmental consciousness in Taiwan. *Impact Assessment Bull*. 1989;8(1):217-231.
 92. Hecker S. Occupational health and safety policy in the European Community: a case study of economic integration and social policy. *New Solutions*. 1993;59-69.